



Atty. Docket No. 201-0309 (FOR25 P-347)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Art Unit : 3611
Examiner : K. Hurley
Applicants : Aaron L. Mills et al.
Appln. No. : 09/683,703
Filing Date : February 5, 2002
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For : STEER-BY-WIRE STEERING SYSTEM WITH ROTATION
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APPELLANT'S BRIEF (37 CFR §1.192)

This brief is in furtherance of the Notice of Appeal, filed in this case on July 31, 2003.

The fees required under §1.17(f), and any required petition for extension of time for filing this brief and fees therefor, are dealt with in the accompanying TRANSMITTAL OF APPEAL BRIEF.

This brief is transmitted in triplicate. (37 CFR §1.192(a)).

This brief contains these items under the following headings, and in the order set forth below (37 CFR §1.192(c)):

- I. Real Party in Interest
- II. Related Appeals and Interferences
- III. Status of Claims
- IV. Status of Amendments
- V. Summary of Invention
- VI. Issues
- VII. Grouping of Claims
- VIII. Arguments

Appendix of Claims Involved in the Appeal

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The final page of this brief bears the attorney's signature.

I. Real Party in Interest

The real party in interest in this application is Ford Global Technologies, Inc. of Dearborn, Michigan, the assignment to which was recorded at Reel 012367, Frame 0563.

II. Related Appeals and Interferences

There are no related appeals or interferences pending under this application.

III. Status of Claims

This is an appeal to the Board of Patent Appeals and Interferences from the decision of the Primary Examiner mailed May 8, 2003 finally rejecting claims 1-3, 5-6, 9-12, 14-18 and 20 in the above-identified patent application.

In summary, claims 1-20 remain in the present application. Claims 1-3, 5-6, 9-12, 14-18 and 20 stand finally rejected, and claims 4, 7-8, 13 and 19 are allowed.

IV. Status of Amendments

An amendment under 37 C.F.R. §1.116 to rewrite claims 4, 7, 13 and 19 in independent form, was filed on October 3, 2003. According to the Notification of Non-Compliance with 37 CFR 1.192(c) mailed October 24, 2003, these amendments have now been entered.

A copy of the claims on appeal is provided in the attached Appendix A.

V. Summary of the Invention

As described in the specification of the subject application, and illustrated in the related drawings, the invention recited in the finally rejected claims generally relates to a unique steer-by-wire steering system 10 including a mechanical steering limit assembly to limit the rotary travel of steering wheel 12 and steering wheel shaft 16. The mechanical steering limit assembly avoids the need for an electric motor to generate a locking force, and thereby avoids the drawbacks associated with such arrangements.

With reference to Fig. 1, the steer-by-wire steering system 10 steers a pair of road wheels 40A and 40B of a vehicle (specification page 3, paragraph 12). A steering input device such as rotatable steering wheel 12 is rotatable by an operator to command steering of the road wheels 40A and 40B. A steering wheel shaft 16 is rotatable directly in response to rotation of

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the steering wheel 12. An electric feedback motor 20 is connected to the steering wheel shaft 16 via gear 22 to provide feedback resistance force to the steering wheel 12 in response to detected resistance of the road wheels 40A and 40B to provide steering feel for the driver. A steering angle sensor 18 is also coupled to the steering wheel shaft and senses the angular position of the steering wheel shaft 16.

The steer-by-wire steering system 10 also includes a rack and pinion assembly having a tooth rack 34, a pinion gear assembly 32, a pinion shaft 30 (specification page 4, paragraph 14). The pinion shaft 30 is not mechanically linked to the rotary shaft 16. Rather, pinion shaft 30 is rotary driven by an electric drive motor 26 in response to a motor control output signal received from a steering controller 24. Accordingly, the pinion shaft 30 is rotary actuated in response to the control output signal generated by the steering controller 24, instead of employing a direct mechanical linkage between the steering shaft 16 and pinion shaft 30.

With reference to Fig. 2, rotary shaft 16 and steering column 14 are configured with a mechanical rotary limiter assembly to limit the rotary travel of the steering wheel 12 and steering wheel shaft 16 in both the clockwise and counter-clockwise rotations to stop rotary movement at predetermined stop positions. Steering wheel shaft 16 has a female receptacle configured as a slot 50 formed therein that extends spirally a predetermined number of rotations about the steering wheel shaft 16. According to one example, the slot 50 extends for three complete (360°) turns to thereby limit rotary travel of the steering wheel 12 to three turns.

A base slider 44 includes a pin 46 which extends into mating engagement with slot 50. Slider 44 is disposed within a slot 43 formed within a support member such as the steering column housing 14, such that the male member is prevented from rotating, yet the slider 44 and pin 46 traverse axially along the steering wheel shaft 16 during use such that the pin 46 remains in engagement with slot 50 as the steering wheel shaft 16 rotates.

Opposite ends of slot 50 are defined by first and second end walls 52 and 54 which serve as rotary stop positions which prevent further rotation of the steering wheel shaft 16. Pin 46 is able to travel within slot 50 until pin 46 engages either of the end walls 52 and 54.

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End walls 52 and 54 provide stop positions which limit the travel of the rotary shaft 16 and thus limit the rotation of movement of the steering wheel 12.

VI. The Prior Art

Hanger, Jr. U.S. Patent No. 1,083,399

Dated January 6, 1914

Hanger, Jr. discloses a steering mechanism for vehicles including a steering wheel 1 secured to a rotatable steering post 2. A gear post 10 extends into casing 6, and carries a worm and sector, and the arm 11a of the sector being connected to the mechanism for steering wheels (not shown). Ball bearings 12 and 13 are provided for the gear post above and below the worm gear 11. A pawl and gear arrangement prevents the wheels from being turned through encountering stones, ruts, or other obstructions in the road, and prevents such shocks from being transmitted to the operator of the vehicle through the steering post, and which remains in a locked position until changed by the operator.

The Remaining References

The remaining references of record have not been specifically applied by the Examiner to the rejected claims, and are believed to be not sufficiently related to the appealed claims to warrant separate discussion.

VII. Examiner's Rejections

A. The Examiner's Rejections under 35 U.S.C. §103(a):

1. The Examiner finally rejected claims 1-3, 5-6, 9-12, 14-18 and 20 as being unpatentable over Hanger, Jr. U.S. Patent No. 1,083,399.

VIII. Issues

1. Whether claims 1-3, 5-6, 9-12, 14-18 and 20 are unpatentable under 35 U.S.C. §103(a) over Hanger, Jr. U.S. Patent No. 1,083,399.

IX. Grouping of Claims

Claims 1-3, 5 and 6 stand or fall together. Claims 9-12, 14 and 15 stand or fall together. Claims 16-18 and 20 stand or fall together.

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X. Arguments

Issue 1: Did the Examiner correctly reject claims 1-3, 5-6, 9-12, 14-18 and 20 under 35 U.S.C. §103(a) as being unpatentable over Hanger, Jr. U.S. Patent No. 1,083,399?

The Examiner's basis for rejecting claims 1-3, 5-6, 9-12, 14-18 and 20 under 35 U.S.C. §103(a) is that,

Hanger, Jr. discloses a steering mechanism comprising:
a steering input device 1 comprising a steering wheel rotatable by an operator to command steering of the one or more road wheels;

a steering input shaft 10 mechanically connected to the steering input device and rotatable in response to rotation of the steering input device;

a support member 6 disposed proximate the steering input shaft;

a male member (sector gear) provided on the support member and having a pin;

a female receptacle 11 comprising a slot provided on the steering input shaft comprising at least one stop position; and

an actuator 11a for rotating one or more wheels in the vehicle in response to rotation of the steering input device.

Hanger, Jr. fails to disclose the steering input shaft not being mechanically linked to the steered road wheels.

However, it would clearly be obvious to one of ordinary skill in the art that input shaft would not be mechanically linked to the steered road wheels during assembly of the vehicle and/or during repair or salvage of the vehicle.

Claim 1 defines Applicants' steer-by-wire steering system for steering one or more road wheels on a vehicle. The system includes a steering input rotatable by an operator to command

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steering of the one or more wheels, and a steering input shaft mechanically connected to the steering input device and rotatable in response to rotation of the steering input device. The steering input shaft is not mechanically linked to the steered one or more road wheels. The steering system also includes a support member disposed proximate the steering input shaft, and a male member provided on one of the steering input shaft and the support member. A female receptacle is provided on the other of the steering input shaft and the support member for receiving the male member. The female receptacle comprises at least one stop position for limiting rotational travel of the steering input shaft. The steering system further includes an actuator for rotating one or more wheels in the vehicle in response to rotation of the steering input device.

Dependent claim 2 further defines the steering system of claim 1 by providing that the female receptacle comprises a slot and the male member comprises a pin. Claim 3 depends from claim 2, and provides that the slot is formed in the steering input shaft and the pin is provided on the support member. Claim 5 depends from claim 1, and provides that the support member comprises a steering column housing. Claim 6 depends from claim 1, and provides that the steering input device comprises a steering wheel.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in applicant's disclosure. MPEP 2143; *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

For those reasons discussed in more detail below, Applicants assert that the Examiner has not established a *prima facie* case of obviousness.

Applicants assert that Hanger, Jr. does not disclose a female receptacle including at least one stop position for limiting rotational travel of a steering input shaft as recited in claim 1, such that Hanger, Jr. cannot anticipate or render claim 1 obvious for this reason alone. Furthermore,

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Hanger, Jr. does not disclose or suggest a steer-by-wire steering system wherein the steering input shaft is not mechanically linked to the steered one or more road wheels as recited in claim 1. The invention of claim 1 provides a mechanical stop to limit the rotation of a steering input device such as a steering wheel in steer-by-wire steering systems. Hanger, Jr. does not recognize the problems associated with prior steer-by-wire systems that lacked such a mechanical stop. Applicants note that "a patentable invention may lie in the discovery of the source of a problem even though the remedy may be obvious once the source of the problem is identified. This is *part* of the 'subject matter as a whole' which should always be considered in determining obviousness of an invention under 35 U.S.C. §103." *In re Spinnoble*, 160 USPQ 237 (CCPA 1969) (emphasis added). Applicants respectfully submit that when the steer-by-wire steering system of claim 1 is considered as a whole, it is clear that Hanger, Jr. does not recognize the problems solved by the present invention, and provides no teaching or suggestion to modify Hanger, Jr. to provide such a stop.

Furthermore, Hanger, Jr. actually teaches a mechanical linkage between the steering post and the vehicle wheels, such that the Examiner's position concerning the teaching of Hanger, Jr. is speculative and unreasonable. The absence of such a mechanical linkage is one of the primary differences between steer-by-wire systems and the mechanical system disclosed in Hanger, Jr. Applicants note that a proposed modification cannot render the prior art unsatisfactory for its intended purpose. MPEP 2143.01. Furthermore, the proposed modification cannot change the principle of operation of a reference. MPEP 2143.01. Quite simply, without a mechanical link, Hanger, Jr. cannot operate for its intended purpose, and the reference itself does not teach or suggest modification to eliminate the mechanical link.

Claims 2-3 and 5-6 depend from claim 1, and are therefore allowable for those reasons set forth above with respect to claim 1.

Claim 9 is somewhat similar to claim 1 and recites a steer-by-wire steering system for steering one or more steerable members on a steered vehicle. The system includes, among other features, a steering input device rotatable by an operator to command steering of the one or more steerable members. The other features of claim 9 are substantially identical to claim 1, such that a detailed discussion of these features is not believed to be required.

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Independent claim 9 is believed to be allowable for substantially the same reasons as set forth in detail above in connection with claim 1. Hanger, Jr. does not teach a steer-by-wire steering system, and does not recognize the problems associated with such systems. Furthermore, Hanger, Jr. also does not disclose a female receptacle that comprises at least one stop position for limiting rotational travel of the steering input shaft. Still further, Hanger, Jr. teaches a mechanical link between the steering post and the wheels being steered; elimination of such a mechanical link would render the Hanger, Jr. steering mechanism unsatisfactory for its intended purpose. Accordingly, the actual teaching of Hanger, Jr. is contrary to the steer-by-wire system recited in claim 9.

Claims 10-12 and 14-15 depend from claim 9, such that these claims are believed to be allowable for those reasons set forth above with respect to claim 9.

Independent claim 16 recites a steering assembly for a steer-by-wire steering system for steering one or more road wheels of a vehicle. The steer-by-wire system of claim 16 is substantially similar to the steering system of claim 1, except that claim 16 does not recite an actuator for rotating one or more wheels in the vehicle in response to rotation of the steering input device as recited in claim 1.

Applicants submit that Hanger, Jr. does not disclose or suggest the steering assembly of claim 16 for substantially the same reasons as set forth above in connection with claim 1. Hanger, Jr. does not teach a steer-by-wire steering system, and does not recognize the problems associated with such systems. Furthermore, Hanger, Jr. also does not disclose a female receptacle that comprises at least one stop position for limiting rotational travel of the steering input shaft. Still further, Hanger, Jr. teaches a mechanical link between the steering post and the wheels being steered; elimination of such a mechanical link would render the Hanger, Jr. steering mechanism unsatisfactory for its intended purpose. Accordingly, the teaching of Hanger, Jr. is actually contrary to the recited steer-by-wire system.

Claims 17-18 and 20 depend from claim 16 and are therefore believed to be allowable for those reasons set forth above with respect to claim 16.

In proceedings before the Patent and Trademark Office, the Examiner bears the burden of establishing a prima facie case of obviousness based upon the prior art. *In re Fritch*, 23

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USPQ 2d 1780, 1783 (Fed. Cir. 1992). Applicants respectfully assert that the Examiner has not yet met his burden of establishing a prima facie case of obviousness with respect to the rejected claims. Consequently, the Examiner's rejection of the subject claims is inappropriate, and should be overturned.

Respectfully submitted,

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Appendix of Claims (37 CFR §1.192(c)(9))

1. A steer-by-wire steering system for steering one or more road wheels on a vehicle, said steering system comprising:
 - a steering input device rotatable by an operator to command steering of the one or more road wheels;
 - a steering input shaft mechanically connected to the steering input device and rotatable in response to rotation of the steering input device, wherein the steering input shaft is not mechanically linked to the steered one or more road wheels;
 - a support member disposed proximate the steering input shaft;
 - a male member provided on one of the steering input shaft and the support member;
 - a female receptacle provided on the other of the steering input shaft and the support member for receiving the male member, wherein the female receptacle comprises at least one stop position for limiting rotational travel of the steering input shaft; and
 - an actuator for rotating one or more wheels in the vehicle in response to rotation of the steering input device.
2. The steering system as defined in claim 1, wherein said female receptacle comprises a slot and said male member comprises a pin.
3. The steering system as defined in claim 2, wherein the slot is formed in the steering input shaft and the pin is provided on the support member.
4. A steer-by-wire steering system for steering one or more road wheels on a vehicle, said steering system comprising:
 - a steering input device rotatable by an operator to command steering of the one or more road wheels;
 - a steering input shaft mechanically connected to the steering input device and rotatable in response to rotation of the steering input device;
 - a support member disposed proximate the steering input shaft;

a male member provided on one of the steering input shaft and the support member;
a female receptacle provided on the other of the steering input shaft and the support member for receiving the male member, wherein the female receptacle comprises at least one stop position for limiting rotational travel of the steering input shaft;

an actuator for rotating one or more wheels in the vehicle in response to rotation of the steering input device; wherein said female receptacle comprises a slot and said male member comprises a pin; wherein the slot is formed in the steering input shaft and the pin is provided on the support member; and wherein the pin is slidable within the slot and the support member prevents rotation of the pin.

5. The steering system as defined in claim 1, wherein the support member comprises a steering column housing.

6. The steering system as defined in claim 1, wherein said steering input device comprises a steering wheel.

7. A steer-by-wire steering system for steering one or more road wheels on a vehicle, said steering system comprising:

a steering input device rotatable by an operator to command steering of the one or more road wheels;

a steering input shaft mechanically connected to the steering input device and rotatable in response to rotation of the steering input device;

a support member disposed proximate the steering input shaft;

a male member provided on one of the steering input shaft and the support member;

a female receptacle provided on the other of the steering input shaft and the support member for receiving the male member, wherein the female receptacle comprises at least one stop position for limiting rotational travel of the steering input shaft;

an actuator for rotating one or more wheels in the vehicle in response to rotation of the steering input device; and further comprising a pinion shaft coupled to the actuator, wherein the pinion shaft is not mechanically linked to the steering input shaft.

8. The steering system as defined in claim 7, wherein said actuator comprises an electric motor.
9. A steer-by-wire steering system for steering one or more steerable members on a steered vehicle, said steering system comprising:
 - a steering input device rotatable by an operator to command steering of the one or more steerable members;
 - a steering input shaft mechanically connected to the steering input device and rotatable in response to rotation of the steering input device, wherein the steering input shaft is not mechanically linked to the steered one or more steerable members;
 - a support member disposed proximate the steering input shaft;
 - a male member provided on one of the steering input shaft and the support member;
 - a female receptacle provided on the other of the steering input shaft and the support member for receiving the male member, wherein the female receptacle comprises at least one stop position for limiting rotational travel of the steering input shaft; and
 - an actuator for actuating one or more steerable members in the vehicle in response to rotation of the steering input device.
10. The steering system as defined in claim 9, wherein said female receptacle comprises a slot and said male member comprises a pin.
11. The steering system as defined in claim 10, wherein the slot is formed in the steering input shaft and the pin is provided on the support member.
12. The steering system as defined in claim 9, wherein the support member comprises a steering column housing.
13. A steer-by-wire steering system for steering one or more steerable members on a steered vehicle, said steering system comprising:

a steering input device rotatable by an operator to command steering of the one or more steerable members;

a steering input shaft mechanically connected to the steering input device and rotatable in response to rotation of the steering input device;

a support member disposed proximate the steering input shaft;

a male member provided on one of the steering input shaft and the support member;

a female receptacle provided on the other of the steering input shaft and the support member for receiving the male member, wherein the female receptacle comprises at least one stop position for limiting rotational travel of the steering input shaft;

an actuator for actuating one or more steerable members in the vehicle in response to rotation of the steering input device; wherein the support member comprises a steering column housing; and wherein the male member is axially slidable in a channel formed in the housing and the channel prevents the male member from rotating.

14. The steering system as defined in claim 9, wherein said steering input device comprises a steering wheel.

15. The steering system as defined in claim 9, wherein the one or more steerable members comprise one or more road wheels.

16. A steering assembly for a steer-by-wire steering system for steering one or more road wheels of a vehicle, said steering assembly comprising:

a steering input device rotatable by an operator to command steering of one or more road wheels of the vehicle;

a steering input shaft mechanically connected to the steering input device and rotatable in response to rotation of the steering input device, wherein the steering input shaft is not mechanically linked to the steered one or more road wheels;

a support member disposed proximate the steering input shaft;

a male member provided on one of the steering input shaft and the support member; and

a female receptacle provided on the other of the steering input shaft and the support member for receiving the male member, wherein the female receptacle comprises at least one stop position for limiting rotational travel of the steering input shaft.

17. The steering assembly as defined in claim 16, wherein said female receptacle comprises a slot and said male member comprises a pin.

18. The steering assembly as defined in claim 16, wherein the slot is formed in the steering input shaft and the pin is provided on the support member.

19. A steering assembly for a steer-by-wire steering system for steering one or more road wheels of a vehicle, said steering assembly comprising:

- a steering input device rotatable by an operator to command steering of one or more road wheels of the vehicle;

- a steering input shaft mechanically connected to the steering input device and rotatable in response to rotation of the steering input device;

- a support member disposed proximate the steering input shaft;

- a male member provided on one of the steering input shaft and the support member;

- a female receptacle provided on the other of the steering input shaft and the support member for receiving the male member, wherein the female receptacle comprises at least one stop position for limiting rotational travel of the steering input shaft; and wherein the support member comprises a steering column housing having a slot for retaining the male member so as to prevent rotation of the male member while allowing the male member to slide within the female receptacle.

20. The steering assembly as defined in claim 16, wherein said steering input comprises a steering wheel.